Quantum Institute Workshop

Quantum Institute Briefing Center; December 9–10, 2002

Quantum Measurement in Condensed Matter Systems

(Ivar Martin, T-11)

Goal: Design and analysis of quantum measurement procedures for quantum computing, quantum devices, and local probes

- *Single spin spectroscopy/measurement*
  - *Proposal for single spin measurement in a superconductor (**PRL 88**, 037003 (2002))*
  - *Scheme for measurement of single spin ESR for electrons trapped in FET (**PRL**, in press)*
  - *Single electron relaxation in Magnetic Resonance Force Microscopy (**APL**, accepted)*
    - *Output noise of a measuring device at arbitrary voltage and temperature (cond-mat/0211618)*
  - *STM measurement of ESR (cond-mat/0112407)*
- *Ultra-sensitive displacement measurement*
  - *Measurement-induced Quantum-Classical transition (**PRL 89**, 018301 (2002))*
  - *Quantum measurement in correlated non-equilibrium environments (cond-mat/0207005)*
  - *Inelastic vibrational spectroscopy*

People involved:

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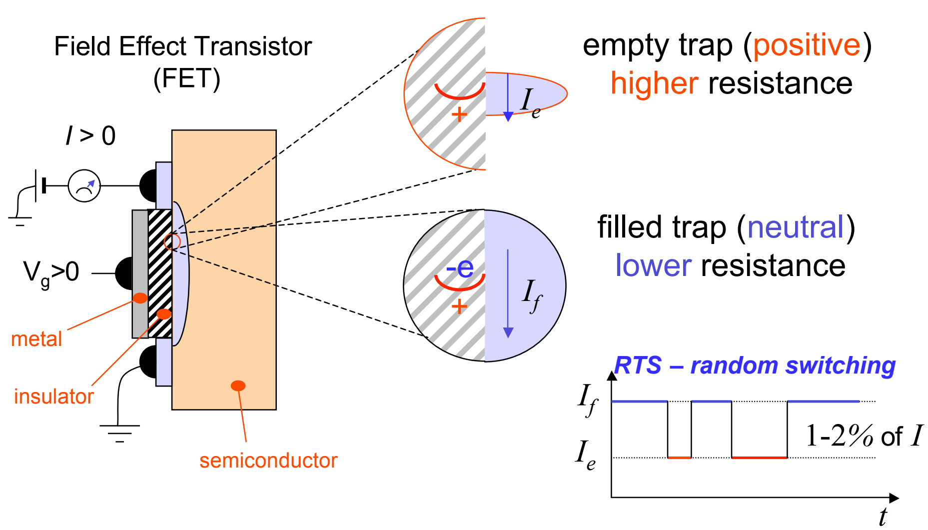
Traps and RTS



Presenter: Ivar Martin

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ESR-RTS setup

At $T = 0$, $B_1 = 0$:

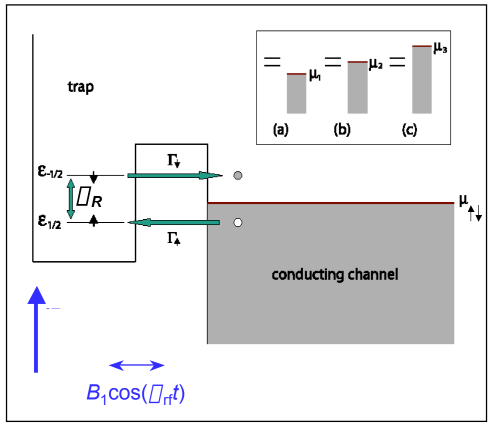
trap is filled if □$_{1/2}$ < □
trap is empty if □$_{1/2}$ > □

NO RTS!

At $T = 0$ and resonant $B_1(t)$:

trap can be filled if □$_{1/2}$ < □
e$^-$ is promoted □$_{1/2}$ -> □$_{1/2}$
e$^-$ can escape if □$_{1/2}$ > □

ESR-induced RTS!



I. Martin, D. Mozyrsky, H.W. Jiang, (PRL in press)

At finite temperature RTS is *modified* by resonant $B_1(t)$

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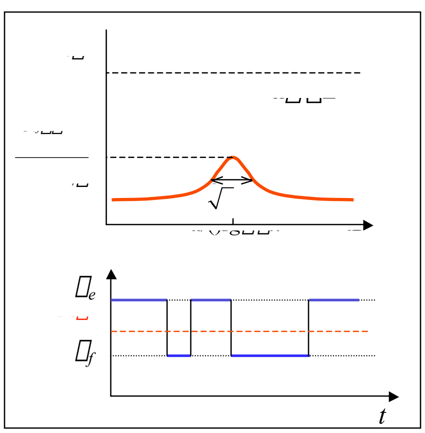
Resonance in average resistance

$$\rho(B_0) = \rho_f + \frac{(\rho_e - \rho_f)\,\omega_R^2}{4(g\mu_B B_0/\hbar - \omega_{\rm rf})^2 + \Gamma^2 + 3\omega_R^2}$$

In presence of dephasing (T_2' >> □):

peak width: $(1/T_2')\sqrt{1 + 3\omega_R^2 T_2'/(2\Gamma)}$

peak height: $1/[3 + 2\Gamma/(\omega_R^2 T_2')]$



ERS-RTS Summary:

- *–Conversion of single spin measurement problem into single charge measurement*
- *–Possible to extract single spin relaxation*
- *–Pulsed manipulations – applications to quantum computing*

Example of strong quantum measurement